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JULY MEETING OF THE Massachusetts Association of Boards of Health.

The July quarterly meeting of the Association was held at Gallup's Island, Boston Harbor, on the afternoon of July 19, 1900, the President, Dr. H. P. Walcott, in the chair. The papers presented to the meeting and the discussion thereon follow:—

SERVICE PIPES FOR WATER SUPPLIES WHICH COR- RODE LEAD AND OTHER METALS.

BY R. S. WESTON.

The so-called "lead-pipe question," though not a new subject for discussion, has reappeared with a renewed interest in this State, partly because of the increased care with which matters relating to the public health are being studied and partly on account of the recent publication by the State Board of Health of a report upon certain wide-spread cases of plumbism of a serious nature.

Lead-poisoning is, of course, a familiar subject to all of you; and it is not my intention to discuss either the toxicity of water containing small amounts of lead or the maximum amount of lead which

can be safely allowed in a water supply, with due regard to the public health, but rather to call your attention to the various kinds of service pipes in common use, and discuss with you their comparative values from a sanitary and chemical standpoint. The discussion from the hygienic standpoint was ably led by Dr. Abbott at the last meeting.

The chief kinds of service pipes and their present comparative cost for the 1-inch size are tabulated in the table below:—

		<i>Price per linear foot.</i>
Plain black wrought iron		\$0.08
Tarred " "09
Cement-lined " "11
Galvanized " "11
Lead-lined " "225
Tin-lined " "48
Plain lead (Boston weight)36
Tin-lined lead72
Brass36
Wood (1½ in.)11

Of these kinds of pipe, the plain, tarred, galvanized, and cement-lined iron and the plain lead pipe are most commonly used. Lead-lined iron pipe has been supplanting lead pipe of late, but the cost of tin-lined pipe is generally prohibitive. The same may be said of the brass or composition pipe, except for inside house connections.

From a sanitary standpoint, all pipes may be classed according to the character of the surface in contact with the water. All of these surfaces are of metal or wood, or metal protected by some coating or lining. The exposed metal surfaces are iron, zinc, lead, tin, copper, and brass.

At this point it may be stated, as a general rule, that the waters which dissolve one metal will dissolve any other commonly used metal. Chemically pure water, simply H₂O, does not appreciably attack any of the metals commonly used for services. However, the presence of oxygen or carbon dioxide in an otherwise pure water makes it more or less of a corrosive agent. Hence most natural waters have some action on metals.

These gases in solution, singly or combined, are the two principal factors in ordinary waters which effect the solution of exposed metal surfaces in service pipes.

I will take up in detail each of the varieties of pipe in the table, and have here samples of each for your inspection.

Wrought-iron Pipe.—Wrought-iron pipe is the cheapest of all services and the one most generally used. Its advantages are, among others, its low cost, its convenience, and its non-poisonous nature, when dissolved in drinking water. Its disadvantages, however, are many. It rapidly rusts and corrodes, and often fills up solidly with rust and scale after a short period of service. Therefore, it is neither durable nor economical. The water from such services stains closets, bowls, and sinks, converts the universal beverage — tea — into ink, and often plays havoc with the family washing.

Galvanized Zinc-plated Pipe.—Zinc is a slight protection only on account of its solubility in waters which attack iron and other metals. The zinc dissolves from the iron pipe in such waters, leaving, of course, the iron surface exposed to the water with all the disadvantages of the latter metal. Zinc, however, is not a cumulative poison in amounts liable to exist in water drawn from galvanized iron services. Galvanizing protects the outside of the service against the action of the soil to a great extent.

Lead.—Lead has been used for conveying water since ancient times. Ancient cisterns were lined with lead, and the Roman aqueducts were made water-tight with the same metal. Cases of lead-poisoning were noted during the Middle Ages.

There are many reasons for using lead pipe for services. It is pliable and easily worked. Therefore, the settling of water mains, sewers, and soil, does not cause it to break, neither is it necessary to be so careful about the trenching and laying as when stiff iron pipe is used. It is very durable in most cases, and does not fill up with rust, neither does it scale off in distinguishable flakes.

On the other hand, lead pipe is expensive to buy and to work, and, as is well known, is soluble in certain waters, especially in the soft-ground waters of New England. This solubility is, of course, the primary cause of lead-poisoning. This solution is practically prevented in certain waters, notably in the hard, clayey waters of the West by substances already in solution, such as silica, which retard the action of the water, and by substances in solution and suspension, such as carbonates and clay, which ultimately cause the forma-

tion of protective coatings on the inside of the pipe, practically preventing further corrosion or solution. The chief constituent of these protective coatings is a basic carbonate of lead, the exact formula of which, however, is not known. This basic carbonate acts as a matrix in some cases, binding some of the suspended matter into a coating. Lead pipe is quite satisfactory where the character of the water is such that solution is practically nil. Lead-lined iron pipe has most of the advantages and disadvantages of plain lead pipe. It costs less, however.

Tin-lined Lead and Tin-lined Iron Pipe.—Tin is the least soluble and, next to iron, the least toxic and the most satisfactory of all the metals usually exposed to water in service pipes; but its high cost is against its general use. No protective coatings form on tin, and the metal is quite rapidly dissolved in certain waters. This solution may be aided by galvanic action caused by impurities in the tin itself; but pure tin is quite soluble in water containing free carbon dioxide and dissolved oxygen. Although the tin thus dissolved is not dangerous to the public health, the lead or iron pipe underneath may be laid bare, with the consequent evils resulting previously referred to.

Brass and Copper Pipes.—Brass and copper pipes are used for hot water pipes and for other house connections. Waters which attack lead, iron, and tin, may also attack copper and brass. Cases of copper-poisoning are rare, however; and the use of this metal where convenience and appearance demand it is allowable.

The characteristics of metal pipes are tabulated below.

(Figures denote the relative degrees.)

	<i>Solubility.</i>	<i>Toxicity.</i>	<i>Durability.</i>	<i>Cost.</i>
Plain iron	1	5	6	1
Galvanized iron	2	2	5	2
Lead	3	1	3	4
Lead-lined iron	3	1	4	3
Tin-lined iron	4	4	2	6
Copper (brass)	5	3	1	5

The best pipe to use in any particular case must be determined largely by local conditions. No general rule can be laid down. Often an investigation is necessary. If upon investigation the ex-

pert finds that a water supply dissolves lead service pipes or that cases of lead-poisoning occur or are liable to occur, what remedy is there?

Obviously, lead pipe services are out of the question; brass and tin lined pipe, at present prices, are generally prohibited by their cost; galvanized pipe is too short-lived to be economical; and plain iron cannot be used advantageously on account of corrosion and iron rust. Therefore, the logical thing to do is either to use wooden pipes or to protect iron pipes with some durable and non-disintegrating coating.

Wooden Pipes.—Wooden pipes have been used for centuries, but until lately they have not been made to withstand pressures of over fifteen to twenty-five pounds. The manufacture of wooden pipes has developed with hydraulic mining; and they are now being used extensively in the West for water services, one company alone having orders for over fifty miles for the season's delivery. These wooden pipes withstand pressure up to two hundred pounds. They are durable, and do not impart any odor or taste to the water. They are not made smaller than 1.5-inch internal diameter, which size costs less, however, than galvanized iron 1 inch in diameter.

Wooden pipes cannot be so easily jointed and prepared as metal pipe. They cannot be used, therefore, in confined places, and are undesirable in exposed work on account of their unavoidable clumsiness. Nevertheless, they have their uses.

Wrought-iron pipe is a very convenient pipe to work; and, if this can be protected by suitable economical coatings, it would be the best pipe for all-round use. The outside of wrought-iron pipe can be practically protected by asphaltic or japan coatings, but such coatings cannot be readily applied to the insides of pipes and couplings.

Several lining materials have been used for wrought-iron pipe. Among them, enamel, tar, and cement are in common use. Enamel and tar linings disintegrate and scale off, and some of them impart a taste to the water. They have not been considered effective and economical for these reasons. Pipe lined with natural cements have now been in use for some decades, and, as the methods of lining are becoming better understood, are more in favor than ever.

Cement-lined pipes were not used for a long time because of the difficulty of lining the joints. This difficulty, with the attendant rusting at the joints, is now overcome by inserting composition thimbles, which protect the couplings and other fittings against the corrosive tendencies of the water, if they are skilfully put in. Tin-lined iron couplings are being used at Taunton with success.

The success of cement-lined pipe depends upon the care with which the lining is performed.

Cement-lined pipe is not usually sold by the dealers, but is lined by the user. The best lining is effected by giving the pipe one coat of cement, allowing it to partially set, and then finishing with a thin coating of cement grout. This last coating fills up any pores in the first coating which may have been left, and causes the inside of the pipe to have a smooth surface. Coatings should be made of light-gravity, neat cement. The cement should be sifted before use.

Cement-lined pipes can be bent but slightly, and are necessarily larger externally for a given discharge than iron or lead pipe; but, when well lined, they make very satisfactory water services, and retain their carrying capacity indefinitely, being free from tuberculation or other incrustation. Brookline has been using cement-lined pipes for over twenty-seven years with uniform success; and Taunton, Waltham, and many other municipalities have done likewise. The outside of the cement-lined pipes should be covered with an asphalt or tar coating, to protect them against the action of the soil.

In conclusion, we may therefore say:—

All waters attack metals more or less, the amount of action depending upon their chemical composition.

Corrosive waters should not be conveyed in unprotected metal (except tin) pipes, especially not in lead pipes.

The only practical substitute for metal is wood, and even this is inferior to cement-lined pipe because of its clumsiness and large size.

Cement-lined pipe, if well made, will last a very long time; and, now that means of protecting the joints have been perfected, it seems to be the best service pipe to use with metal-solvent waters, especially where tin-lined iron is too expensive.

DR. BENNETT F. DAVENPORT.— I am very much interested in this subject, as I have been for several years chairman of the Water Board as well as of the Board of Health of Watertown. We have had experience with all the usual kinds of pipe; but we have used the cement-lined iron pipe in our newer work, and consider it the best there is. I have had unusual personal experience with tin-lined lead pipe. Inspection of some of the pipe made by one of our most reputable companies disclosed the fact that the interior surface of the pipe — the tinned surface — was all crackled, and, after a year's use, innumerable pits had formed between the crackles, apparently erosions through to the lead surface. I examined the water, but could find no trace of lead in it. The occasion of these erosions I could not determine. Probably it was galvanic action. In bending up and unbending the pipe, the harder tin lining had been cracked through probably. I could not determine why there was no lead in the water.

DR. J. E. SANBORN, Melrose.— We are all familiar with the action of carbon dioxide upon lead pipes; that it forms a carbonate of lead which, coating the inner surface of the pipe with its insoluble covering, has been and may be regarded as a natural protection. But I rise to ask if this may be considered a permanent protection.

Does not this carbonate scale off, exposing a fresh surface of lead to poison the water? and may not this scaling process, with its attendant slow poisoning, continue indefinitely? If so, can we ever feel quite safe in trusting lead pipe, no matter how many years in use nor how thoroughly carbonated inside? I beg to ask for information.

R. S. WESTON, Boston.— There is some danger from some waters, especially those containing but little organic matter to act as a binder of the carbonate. I had a case last fall of this kind. The water was one which had a minimum action on lead, and the sample was taken from a long line of pipe which had not been used for some time. On flushing it, a large amount of carbonate of lead was carried out, so much that the water was plainly turbid therewith. This dislodgement of the protective coating is the great objection to the use of lead pipe. Suspended lead, when taken into the stomach, acts, of course, the same as lead in solution.

B. F. DAVENPORT.— Galvanized iron is iron coated with zinc,

which commercially nearly always contains some lead. In my experience, I have known of an instance where some 200 to 300 feet of galvanized pipe discharged water into a wooden reservoir, the bottom of which became covered with a white sediment. This I found on investigation to be composed almost wholly of lead. I am accustomed to tell people, who ask my advice about buying galvanized iron pipe, that water will surely in time dissolve off the zinc, leaving a pipe inferior to what they would have had, had they bought plain iron pipe in the first place. They have thus the privilege, if they desire, of paying an increased price for an inferior iron pipe.

PROFESSOR L. P. KINNICUTT, Worcester.—Is the so-called rustless iron pipe used any? There is or was considerable use of it in Germany. It is prepared by heating the pipes to redness, and passing steam through them, which creates a magnetic oxide. What action does water have on such pipes?

MR. WESTON.—I have known of rustless iron pipes being discussed by those interested in such matters, and of efforts being made to get at information on the subject. But they are not used in this country, at least to any great extent. I have been unable to find any instance of their use. This coating, it seems to me, must be attacked sooner or later, and must be reduced or oxidized. Their use has been generally given up abroad.

DR. GAGE, Lowell.—Is the amount of carbonic dioxide in water a measure of its liability to attack lead pipe?

MR. WESTON.—Other things being equal, yes. The oxygen present will attack the lead, regardless of the carbon dioxide.

F. E. FORBES, Brookline.—For twenty-five years I have given much study to the problem of service pipe,—to find something which will stand the corrosive action of water and yet be a perfectly safe pipe to use, from a sanitary point of view, under all conditions. I have come to the conclusion that cement-lined wrought-iron pipe, with couplings protected with composition ferules, is the best and safest kind of service pipe.

Some waters do not attack lead pipes as badly as others; but we do not know when changes, or what changes, may come to any water supply. Hence we want a pipe which will be safe under all conditions which may arise.

Experience has convinced me that iron pipe can be lined with cement in such a way that the pipe will not rust up, and the water drawn in the houses through it will be of the same quality as that in the mains outside. Such pipe is absolutely safe, cheap, and will last from thirty to fifty years under ordinary conditions.

MR. HILL.—How can private individuals wanting only a few feet of service pipe get cement-lined iron pipe? It is not on the market.

MR. R. S. WESTON.—I would correspond with Mr. Forbes and other water-works superintendents who have had experience with this kind of pipe. They may be able to furnish you with, or tell you where you can get, some. It is not on the general market. If you cannot get cement-lined pipe, I think tin-lined is the next best thing, though wood pipe can be used in some cases. Wood pipe is very useful to convey spring waters for long distances, and has been used on a number of country estates for this purpose.

F. A. WILLARD, Lancaster.—We get cement-lined iron pipe by buying it of the town. Clinton furnishes us with water, and puts in the pipe. We can buy it of that town at cost.

MR. FORBES.—We furnish cement-lined iron pipe in small quantities to any one in Brookline and vicinity for their own grounds.

THE CESSPOOL.

BY LEMUEL P. KINNICUTT, OF WORCESTER POLYTECHNIC INSTITUTE.

Mr. President and Gentlemen,—About ten years ago I had the pleasure of listening to an address given before this society, in which nearly all the ills which humanity is liable to were traced back to the cesspool. The address represented the general opinion held at that time; yet to-day the latest work on sewage disposal shows us that our forefathers, in using the cesspool, were using, unawares, a most efficient method for the disposal of solid putrefying substances. These rapid changes of opinion in sanitary science regarding everyday matters are most confusing; for what we hold as true to-day, we are told to-morrow is all false. We all of us remember the numbers of meetings when plumbers' laws and regulations have been discussed,